CLAIMS:

1. A method for making and screening a combinatorial library comprising:

disposing in a substrate comprising graphite or boron carbide at least one reactant, wherein the reactants are lithium, magnesium, sodium, potassium, calcium, aluminum or a combination comprising at least one of the foregoing reactants;

heat treating the substrate to create a diffusion multiple; contacting the diffusion multiple with hydrogen having at least two phases;

detecting any absorption of hydrogen; and/or

detecting any desorption of hydrogen.

2. The method of Claim 1, wherein the lithium, magnesium, sodium, potassium, calcium, and aluminum are disposed in at least one hole in the substrate.

3. The method of Claim 1, wherein the heat treatment is conducted at a temperature of about 500 to about 1000°C when the substrate is graphite; or a temperature of about 500 to about 1000°C when the substrate is boron carbide.

4. The method of Claim 1, wherein at least one reactant is disposed in the substrate and forms a binary couple upon heat treatment.

5. The method of Claim 1, wherein at least one reactant is disposed in the substrate and forms a ternary triple upon heat treatment.

6. The method of Claim 1, wherein at least two reactants are disposed in the substrate and forms a ternary triple upon heat treatment.

7. The method of Claim 1, wherein the heat treating the substrate is conducted in a nitrogen atmosphere.

8. The method of Claim 1, further comprising identifying an analyzing at least one phase of the diffusion couple using electron microprobe analysis.

9. The method of Claim 1, further comprising slicing and grinding the diffusion multiple.

10. The method of Claim 9, further comprising analyzing the diffusion multiple by electron microprobe analysis or electron backscatter diffraction.

11. The method of Claim 9, wherein the slicing and grinding of the diffusion multiple is conducted after the heat treatment.

12. The method of Claim 1, wherein the determining of the suitability of at least one phase for the adsorption of hydrogen is conducted by time of flight secondary mass ion spectrometry, thermal imaging or by using a tungsten oxide detector.

13. A method of recovering hydrogen comprising:

contacting a compound comprising a carbide in hydrogen to form a hydrogenated compound, wherein the compound is Al_4C_3, Na_4C_3, Li_4C_3, K_4C_3, LiC, LiC_6, Mg_2C_3, MgC_2, $AlTi_2C$, $AlTi_3C$, $AlZrC_2$, Al_3Zr_5C, $Al_3Zr_2C_4$, $Al_3Zr_2C_7$, KC_4, NaC_4, or a combination comprising at least one of the foregoing carbides; and

heating the hydrogenated compound to recover the hydrogen.

14. The method of Claim 13, wherein the heating is conducted using microwave radiation, convectional heating, electrical resistive heating, or a combination comprising at least one of the foregoing methods of heating.

15. The method of Claim 13, further adding a dopant comprising titanium, vanadium zirconium, yttrium, lanthanum, nickel, manganese, cobalt, silicon, gallium, germanium, and the elements from the lanthanide series to the compound in an amount of less than or equal to about 20 wt% of the compound.

16. The method of Claim 13, wherein the heating is effected by the heat from the exhaust of a fuel cell.

17. An energy generation device, wherein the method of Claim 13 is employed to generate energy.

18. A method of recovering hydrogen comprising:

contacting a diffusion multiple having compounds of the formula (II) in hydrogen to form a hydrogenated compound

$$(Li_a, Na_b, K_c, Al_d, Mg_e, Ca_f)_x (B, N, C)_y \qquad (II)$$

where Li is lithium, Na is sodium, Mg is magnesium, K is potassium, Ca is calcium, Al is aluminum; B is boron, C is carbon and N is nitrogen; a, b, c, d, e and f may be the same or different and have values from 0 to 1; and x and y have values of about 1 to about 22; and heating the hydrogenated diffusion multiple to recover the hydrogen.

19. A diffusion multiple containing compounds having the formula (II)

$$(Li_a, Na_b, K_c, Al_d, Mg_e, Ca_f)_x (B, N, C)_y \qquad (II)$$

where Li is lithium, Na is sodium, Mg is magnesium, K is potassium, Ca is calcium, Al is aluminum; B is boron, C is carbon and N is nitrogen; a, b, c, d, e and f may be the same or different and have values from 0 to 1; and x and y have values of about 1 to about 22.

20. The compounds in the diffusion multiple of Claim 19, wherein the sum of a, b, c, d, e, and f is equal to 1.

21. A composition comprising:

a hydride of a compound, wherein the diffusion multiple is Al_4C_3, Na_4C_3, Li_4C_3, K_4C_3, LiC, LiC_6, Mg_2C_3, MgC_2, $AlTi_2C$, $AlTi_3C$, $AlZrC_2$, Al_3Zr_5C, $Al_3Zr_2C_4$, $Al_3Zr_2C_7$, KC_4, NaC_4, or a combination comprising at least one of compound.

22. A system for the storage and recovery of hydrogen comprising:

a hydrogen generation reactor in fluid communication with a hydride recycle reactor, wherein the hydrogen generation reactor utilizes hydrides of light metal carbides to recover hydrogen.

23. The system of Claim 22, wherein the hydrogen generation reactor is in fluid communication with and down stream of a slurry production reactor.

24. The system of Claim 22, wherein the hydrogen generation reactor is in fluid communication with and up stream of a drying and separation reactor.

25. The system of Claim 23, wherein the slurry production reactor is in fluid communication with and downstream of a drying and separation reactor.

26. The system of Claim 22, wherein the hydride recycle reactor is in fluid communication with a slurry production reactor.

27. The system of Claim 22, wherein a metal hydride slurry is transferred to the hydrogen generation reactor from a slurry production reactor.

28. The system of Claim 22, wherein a regenerated metal hydride is transferred from the hydride recycle reactor to a slurry production reactor.

29. The system of Claim 22, wherein water is introduced into the hydrogen generation reactor.

30. The system of Claim 22, wherein hydrogen is generated in the hydrogen generation reactor by the use of heat from microwave radiation, convective heat, exhaust heat from a fuel cell.